Investigating the relationship between force, mass and acceleration

Aim:
To prove Newton's second law, F=ma.

Hypothesis:
We expect to find that as force increases the acceleration will increase. This relationship should be proportional. On the other hand, we expect to find an inversely proportional relationship between mass and acceleration. As the mass increases, the acceleration will decrease.

Apparatus:
- Dynamics trolleys
- Ramp
- Light gates
- Stopwatch
- Masses 100g, 1kg
- String
- Card

Diagram:

Method
1. Set up apparatus as shown in the diagram.
2. Set up light gate computer to measure the acceleration of the trolley as it travels down the ramp.
3. Add a mass on 100g (1N) to the end of the trolley and measure its acceleration as it travels down the ramp. Repeat this twice more. Record all results.

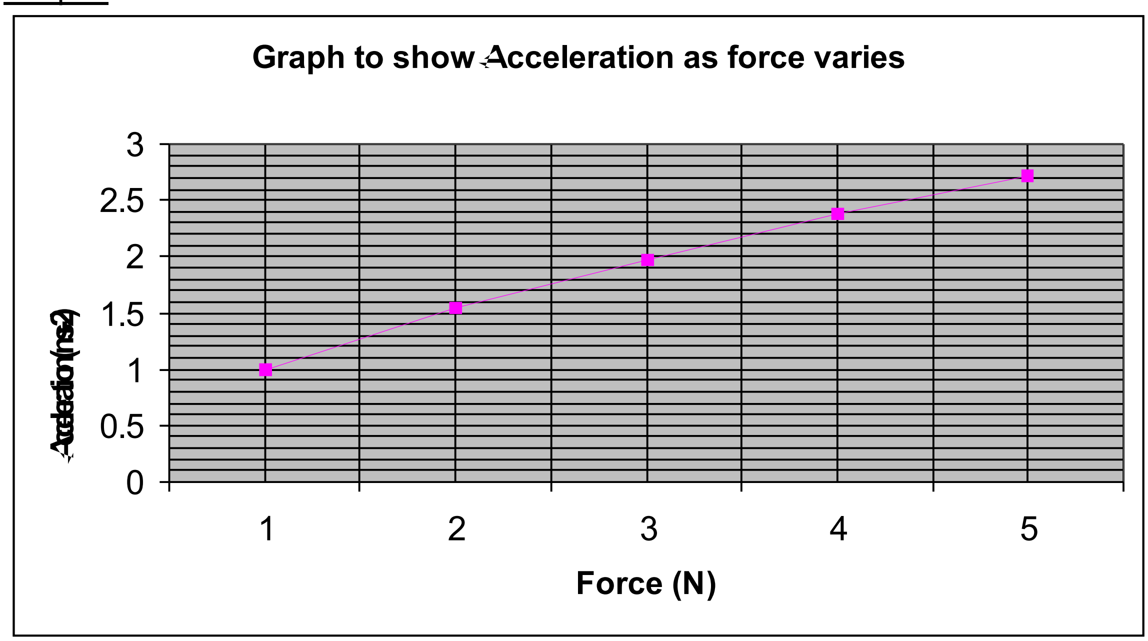
4. Add on another 100g mass to the end and measure the acceleration. Carry on adding masses and taking three readings until you have reached a mass on 500g. This is varying the force acting on the trolley.
5. Next, remove all but one mass of the end of the trolley and add a 1kg weight on top of the trolley. Measure the trolleys new acceleration as it travels down the ramp.
6. Repeat this for a mass of 2kg. This varies the mass of the trolley while keeping the force constant.
7. Plot two graphs of your results. One showing force against acceleration and the other showing mass against acceleration.

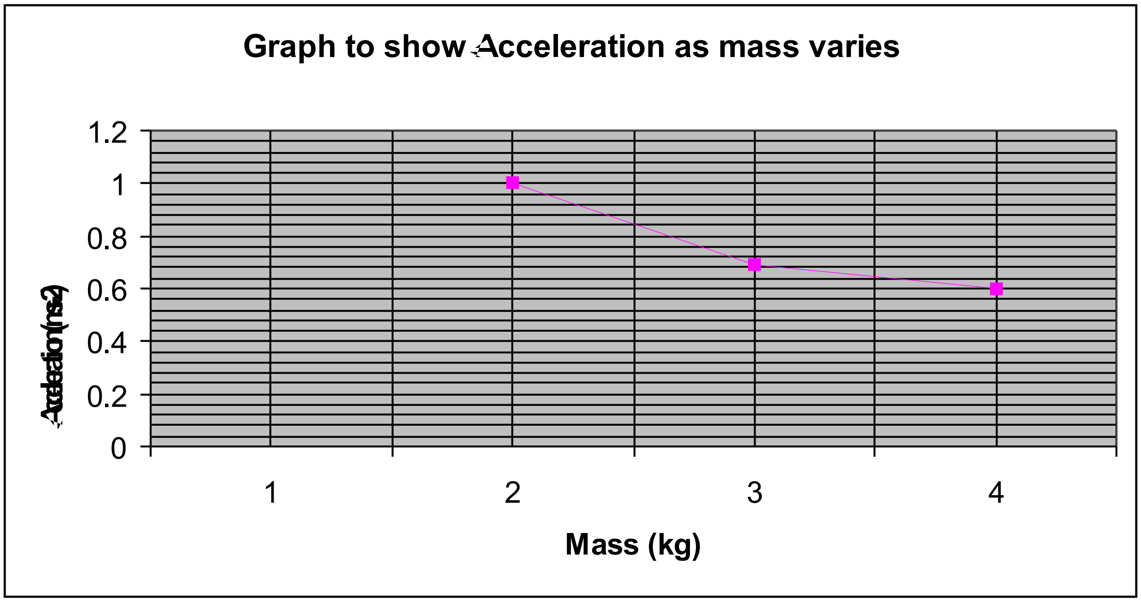
Results:

Force (N)	Acceleration (ms^{-2})			Average Acceleration (ms^{-2})
1	1.00	0.99	1.00	1.00
2	1.53	1.55	1.53	1.54
3	1.98	1.96	1.96	1.97
4	2.38	2.37	2.36	2.37
5	2.71	2.71	2.72	2.71

Mass (kg)	Acceleration (ms^{-2})			Average Acceleration (ms^{-2})
1	1.00	0.99	1.00	1.00
2	0.69	0.68	0.69	0.69
3	0.61	0.60	0.60	0.60

Graphs





Conclusion:
As we can see from the graphs, the hypothesis has been confirmed. There is a proportional relationship between the force and acceleration, and the nearly straight line on the graph shows it. There is an inversely proportional relationship between mass and acceleration and the negative-gradient line on the graph shows it. We would expect these relationships because:

Evaluation:
This experiment has worked well as we were able to prove the hypothesis quite accurately. The experiment allowed us to calculate the acceleration very accurately and was relatively easy to carry out. We encountered a few problems, and improvements need to be made to improve the accuracy of our results. The results for force and acceleration were more accurate than the results for mass and acceleration. This is possibly due to the fact that we assumed the weight of the trolley to be 1kg, when in actual fact it is probably less. To alter the mass more accurately we should stack the trolleys on top of each other. This means that the mass will increase by the same amount each time, the amount of one trolley. This'll probably improve the accuracy of the results.

Another factor that may have caused us to get inaccurate results is the fact that every so often we had to change the position of the mass on the end of the string because we had to stop the mass hitting the floor before it passed the second light gate. To improve this, we should increase the height at which we perform the experiment so the mass would hit the ground later.

Lastly, we should try and increase the distance between the light gates, because the greater the measurement of acceleration, the smaller the inaccuracies. In order to increase the distance between the light gates we need to increase the distance between the mass and the floor.

Overall, the experiment was successful as is gave us relatively straight lines, which show proportional or inversely proportional relationships.